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ORIGINAL ARTICLE

Aesthetic facial perception and need for treatment in simulated laterognathism in male faces of different ethnicities

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Abstract

Purpose This study aimed to compare the aesthetic perception and treatment need in individuals of different ethnicities with various degrees of laterognathism assessed by orthodontists, oral and maxillofacial surgeons, and laypersons.

Methods Three male descendants of different ethnicities were assessed, in which the mandibular deviation was manipulated digitally in different angulations (from 0 to 8°). The assessment was performed by three groups (orthodontists, maxillofacial surgeons, and laypersons ($n = 20$)), and it consisted of scoring the degree of pleasantness of the images presented in a numerical scale and indicating or not a corrective treatment for the respective image.

Results The higher the degree of deviation, the lower the scores assigned to the image ($p < 0.05$). Laypersons assigned the highest scores, with a significant difference between laypersons and oral and maxillofacial surgeons ($p < 0.05$). In terms of treatment need according to the group of evaluators, there were no statistically significant differences among them ($p > 0.05$). Moreover, the increase in degree of deviation increased the perception of treatment need ($p < 0.05$). The African faces received the highest scores, with significant differences from the Caucasian faces ($p < 0.05$). The overall tendency was higher treatment indication for the Caucasian faces, with statistically significant differences from the African faces ($p < 0.05$).

Conclusion The greater the mandibular deviation, the lower the aesthetic pleasantness. Laypersons are less critical regarding the assessment of mandibular deviation. There was no difference for treatment indication by the different groups of evaluators. In addition, ethnicity may influence the perception and treatment indication.

Keywords Esthetics · Facial asymmetry · Mandible · Perception

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Introduction

The beauty standard is subjective and changeable [1], and it is affected by numerous factors over time [2, 3]. Relationships, either romantic [4] or professional [5], are based on what is pleasant in the eyes of each individual and this pattern is affected by environmental and ethnic factors, as well as the media and social networks [6–8].

Following this tendency, the concept of aesthetics in Dentistry has also changed over time. Specialties such as Cosmetic Dentistry [9], Orthodontics [2], and Periodontics [10] have always had their aesthetic concepts renewed at each standard established by society [7]. One of the most desired beauty concepts is facial symmetry, which is commonly associated with aesthetically pleasing [6, 11]. Patients with some type of dentofacial deformity correspond to approximately 20% of the population [12] and form a considerable portion of dental patients who seek the symmetrical pattern [13].

Among the dentofacial deformities, laterognathism may be mentioned, which is characterized by the mandibular deviation to one of the sides affected [14]. The diagnosis is performed mainly by extraoral examination, which shows the existent degree of asymmetry by assessing the proportion of facial thirds [14] using cephalometric examinations [15] or 3D images [16]. Patients with this condition are commonly associated with low self-esteem and aesthetic dissatisfaction, thus seeking corrective procedures [17].

Because it is a visual diagnosis, the aesthetic perceptions of the patient and the professional may diverge, considering that laypersons are less critical than professionals [10, 18]. Moreover, scientific evidence [10, 19, 20] shows that the view of each professional to the patient may vary, which will interfere directly with treatment indication and planning [21].

Thus, the present study aimed to compare the aesthetic perception and treatment need of individuals of different ethnicities with various degrees of laterognathism assessed by orthodontists, oral and maxillofacial surgeons, and laypersons. The authors have tested the following hypothesis: (1) The higher the degree of laterognathism, the lower the aesthetics; (2) orthodontists and oral and maxillofacial surgeons will be more critical for aesthetics than laypersons; (3) orthodontists and oral and maxillofacial surgeons will indicate professional treatment more often than laypersons; (4) ethnicity will influence the perception of laterognathism.

Methods

All Brazilian (Resolution CNS/MS no. 466/2012) and international (Declaration of Helsinki) guidelines related to research ethics involving human beings were respected. The project was approved by an Independent Human Research Ethics Committee (protocol #37580614.0.0000.5546). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [22] was used to aid the research and the reporting of results obtained.

Study design and settings

It is an analytical observational study that assessed digital images of three male descendants of different ethnicities (Caucasian, Asian, and African) selected by the external phenotypic characteristics such as skin color (black, yellow, white), nose shape, and hair texture, which best represent the ethnicities assessed.

Besides the phenotypic characteristics, the following inclusion and exclusion criteria were used for selecting the models: age between 18 and 29 years and passive lip sealing. Individuals who presented any characteristic that could interfere aesthetically (marks, piercings, tattoos, scars, etc.) were excluded.

The models were selected from portfolios of a modeling agency in one city of Brazil. Standardized photographs were taken in frontal view using a professional camera (Canon™ EOS 7D, Melville, NY, USA) with resolution of 300 dpi placed 1 m away from the models. Three Brazilian men classified as descendants of Caucasians, Asians, and Africans were instructed to hold the natural position of the head, looking forward with a neutral expression, and lips slightly sealed.

The photographs taken were imported (resolution of 1366 × 768 pixels) to a computer for correcting small imperfections, mirroring, and simulating mandibular deviation with the Adobe Photoshop™ CS5 photo editing software (Adobe Systems Inc., San Jose, CA, USA).

In order to simulate the mandibular deviation, a vertical reference line was drawn on the midline of the photographs of the symmetrical faces (Fig. 1). Next, the lower facial third was angulated every 2°, from 0 to 8° of deviation. Five images were obtained from each of the three symmetrical faces, resulting in 15 images for assessment (Fig. 2).

Sample characteristics and data collection

The sample included three groups of 20 participants each: laypersons (14 women and 6 men), orthodontists (13 women and 7 men), and oral and maxillofacial surgeons (1 woman and 19 men). Participants from all ethnicities were included. The sample size was set based on previous studies [2, 18]. At the end of the study, in order to verify whether the sample was sufficient to produce reliable results, the statistical power associated with the comparisons performed was calculated using the G*Power software (version 3.1).

Two authors (PBCB and WAV) recruited laypersons from the employees of the university and gave them the printed version of the questionnaire. The laypersons had no

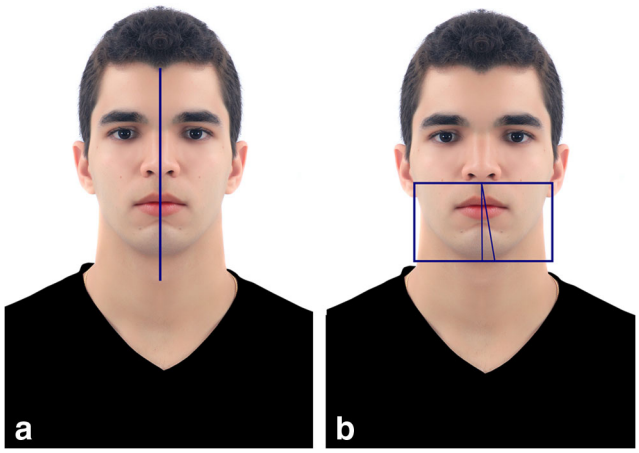

Fig. 1 **a** Image of the model after facial mirroring or symmetrization. **b** Digital simulation of laterognathism

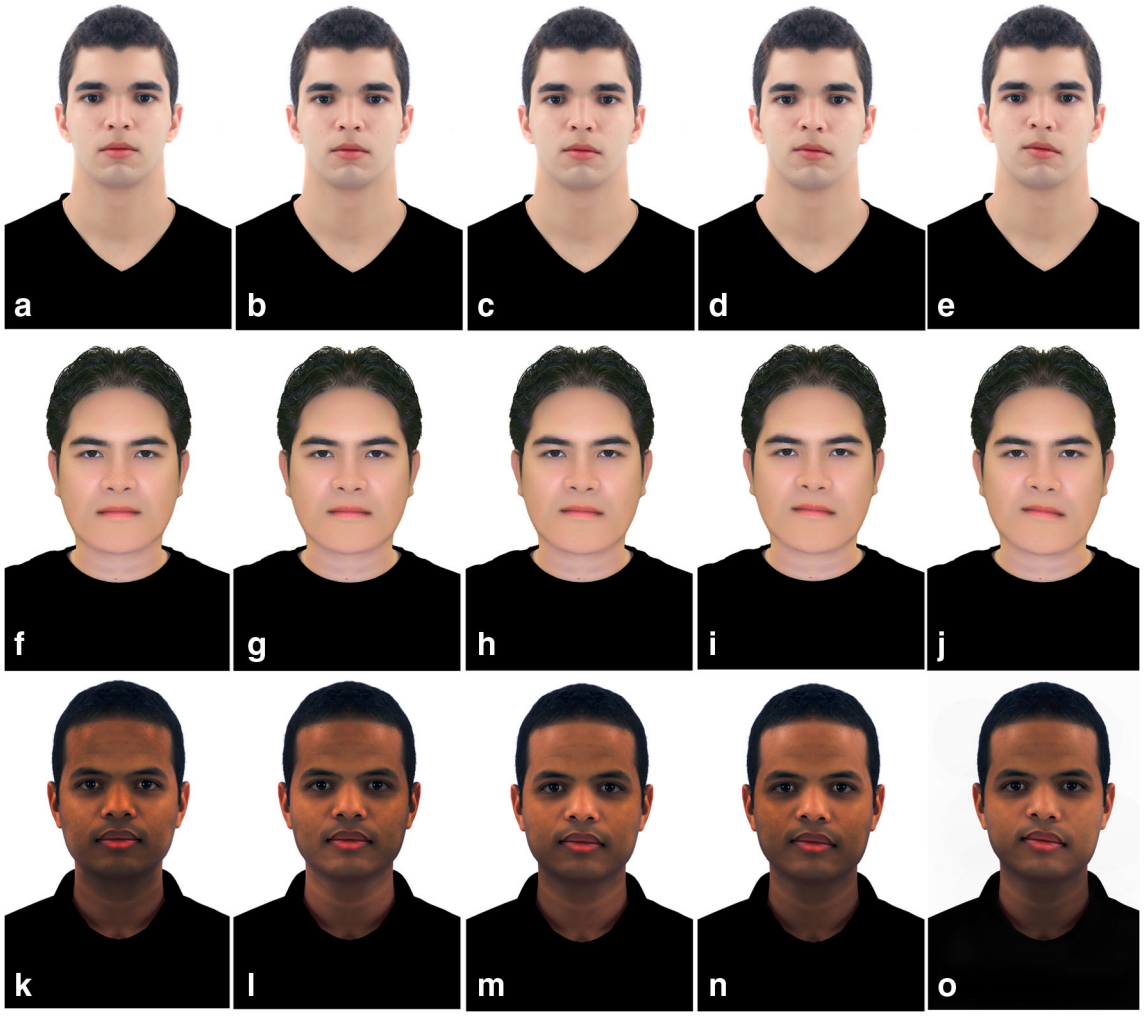

Fig. 2 Mirrored images, with mandibular deviations of 2, 4, 6, and 8° in Caucasian, Asian, and African faces. **a**, **f**, and **k** Mirrored images. **b**, **g**, and **l** Images with 2° of deviation. **c**, **h**, and **m** Images with 4° of deviation. **d**, **i**, and **n** Images with 6° of deviation. **e**, **j**, and **o** Images with 8° of deviation

experience in dentistry and were not made aware of the aims of the study [23].

Orthodontists and oral and maxillofacial surgeons were identified through the registration with the regional dental council. Lists of dentists in alphabetic order were obtained. The list was then organized randomly (http://www.random.org/lists/) and the first 20 in that list were contacted and invited to participate in the study. If the orthodontist or oral and maxillofacial surgeons refuse to participate, the next in the list were chosen until all sample were selected. All participants that agreed to participate in the study signed an informed consent form. Only dentists working as clinicians were approached [21].

The 15 images were organized randomly (http://www.random.org/lists/) in a PowerPoint™ (Microsoft Office 2007, Redmond, USA) slide and they were presented to the evaluators individually on a Dell™ Ultrabook (P35G, São Paulo, Brazil) [6]. Each evaluator received a questionnaire that included questions regarding personal and professional aspects, as well as instructions and questions that guided the assessment of the images for treatment satisfaction and need. After receiving information on the objectives of the study and signing a consent form, the presentation of the images started with the help from one of the authors.

The 15 images were presented to the evaluator, who should assign a score from 0 to 10 for the aesthetic satisfaction of the image (0 = not pleasant, 5 = pleasant, and 10 = extremely pleasant) [24]. The evaluators were also questioned on whether any of the images required some type of treatment (only "yes" or "no" answers) according to their perception. The images of the three models (Caucasian, Asian, and African) were used. The total assessment time was 6 min, with automatic transition of the PowerPoint™ slides.

Data analysis

Initially, a descriptive statistical analysis of the variables was performed to characterize the sample. Quantitative variables were expressed by central tendency and variability measurements, whereas the categorical variables were described by absolute frequencies and percentages. To compare the facial pleasantness scores (quantitative variable) among the groups of evaluators (intergroup analysis) and within the groups (intragroup analysis), the Kruskal-Wallis test and Friedman ANOVA were used, respectively, with multiple mean comparisons by the Bonferroni post hoc test. To compare the prevalence of treatment indication (categorical variable) among the groups of evaluators (intergroup analysis) and within the groups (intragroup analysis), Pearson's chi-square test (or Fisher's exact test, when appropriate) and Cochran Q test were used, respectively. In all analyses, the significance level was set at 5% ($p < 0.05$).

Results

The mean age of evaluators was 36.5 ± 10.32 years (36.7 ± 8.89—orthodontists; 37.9 ± 10.73—oral and maxillofacial surgeons; 35.1 ± 11.52—laypersons), and 32 were men (53.3%) and 28 were women (46.7%). Table 1 shows the comparative analysis results of the facial pleasantness scores assigned by the evaluators according to ethnicity and degrees of mandibular deviation of the images. The study power calculation for the sample was over 80%, considering the facial pleasantness scores assigned by the different groups of evaluators, at $\alpha = 5\%$.

Overall, it was verified that the higher the degree of deviation, the lower the scores assigned to the image ($p < 0.05$). The overall tendency was laypersons assigning the highest scores, followed by orthodontists and oral and maxillofacial surgeons, with a significant difference between laypersons and oral and maxillofacial surgeons for most of the images rated ($p < 0.05$). The faces of the African ethnicity received the highest scores, followed by Asian and Caucasian faces in this order, with significant differences among Caucasian and African faces in the presence of mandibular deviations of 2, 4, and 8° ($p < 0.05$).

In terms of treatment need according to the group of evaluators, there were no statistically significant differences among them ($p < 0.05$) (Table 2). As expected, the increase in degree of deviation increased the perception of treatment need ($p < 0.05$). When comparing treatment need among ethnicities, the overall tendency was higher treatment indication for the Caucasian faces, with statistically significant differences from the African faces in the presence of mandibular deviations of 2, 4, and 8° ($p < 0.05$).

Discussion

The present study compared the aesthetic perception and treatment need of different degrees of mandibular deviation in three men of different ethnicities assessed by orthodontists, oral and maxillofacial surgeons, and laypersons. The results showed lower scores that were directly proportional to the degree of mandibular deviation, considering that laypersons are less critical than orthodontists and oral and maxillofacial surgeons. However, there were no significant differences in treatment indication by the different groups of evaluators. Thus, the first and the second hypotheses were confirmed and the third was rejected.

Facial harmony and its role in aesthetic discernment has been the aim of several studies over the years. In 1965, Lu [25] affirmed that only symmetries over 3% could be perceived clinically. This same affirmation may be concluded in our study, which verified similar scores in variations of 0° and 2°, but a continuous drop as the mandibular deviation became more prominent at 8°. Moreover, several studies indicated that the more symmetrical the face, the most pleasant the aesthetics [21]. However, the study by Springer et al. [11] concluded that even though facial asymmetry plays a major role in aesthetic perception, small facial asymmetries might make the faces more beautiful, depending on the location of the so-called beauty spots. Springer et al. [11] have also concluded that the closer the asymmetry is to the midline, the less attractive the face, but as the asymmetry gets farther, it presents a lower aesthetic value or even a positive one. This conclusion starts an important discussion on the subjectivity of pleasantness assessment, which may be affected by numerous factors such as personal taste, level of visual analysis, and interpretation perception [3].

Considering such subjectivity, another factor accounted for in this study was the professional training of each group of evaluators. A study by Falkensammer et al. [23] concluded that education is a major factor for aesthetic judgment, showing differences between professionals and laypersons. The same results may be observed in the present study, in which laypersons assigned higher scores to mandibular deviations than orthodontists and oral and maxillofacial surgeons. These findings also confirm the results of other studies with similar methods [18, 19]. This difference may be attributed to the more specific training of professionals for detecting such asymmetries. However, a study by Meyer-Marcotty et al. [26] proposed a 3D evaluation method where no difference was observed between the perception of professionals and laypersons, which contradicts the results presented by Falkensammer et al. [23]. This contradiction may be justified by the evaluation being in 3D rather than a 2D image, which diminishes the subjectivity in the assessment. Future studies must focus on the 3D type of assessment aiming at the decrease of subjectivity in the evaluation of the patient.

Table 1 Comparative analysis of the facial pleasantness scores assigned by the evaluators according to ethnicity and degrees of mandibular deviation of the images

Ethnicity/degree of deviations	Total sample ($n = 60$)		Group						
			Orthodontists ($n = 20$)		Oral and maxillofacial surgeons ($n = 20$)		Laypersons ($n = 20$)		
	M	SD	M	SD	M	SD	M	SD	p value[(1)]
Caucasian									
0°	7.37	1.79	7.05^{Aa}	1.57	7.15^{Aa}	1.87	$7.90^{Aa.b}$	1.89	0.213
2°	7.05	1.93	$6.85^{A.Ba}$	2.28	6.30^{Ba}	1.30	8.00^{Ab}	1.78	0.015*
4°	5.85	1.87	$5.85^{A.Ba}$	1.69	5.05^{Bb}	1.79	$6.65^{Ac.b}$	1.84	0.044*
6°	4.63	1.64	4.20^{Bb}	1.01	3.65^{Bc}	1.50	6.05^{Ac}	1.32	< 0.001*
8°	3.47	1.73	2.85^{Bc}	1.46	2.75^{Bd}	1.55	4.80^{Ad}	1.40	< 0.001*
p value[(2)]	< 0.001*		< 0.001*		< 0.001*		< 0.001*		
Asian									
0°	7.77	1.76	8.35^{Aa}	1.31	$6.85^{Ba.b}$	1.98	$8.10^{A.Ba}$	1.62	0.037*
2°	7.90	1.35	8.10^{Aa}	1.25	7.80^{Aa}	1.28	$7.80^{Aa.b}$	1.54	0.775
4°	6.53	1.62	$6.70^{A.Bb}$	1.63	5.80^{Bb}	1.32	$7.10^{Ac.b}$	1.68	0.044*
6°	4.68	1.88	3.95^{Bc}	1.76	4.25^{Bc}	1.92	$5.85^{Ac.d}$	1.42	0.003*
8°	3.73	1.86	2.95^{Bd}	1.73	3.15^{Bd}	1.73	5.10^{Ad}	1.33	< 0.001*
p value[(2)]	< 0.001*		< 0.001*		< 0.001*		< 0.001*		
African									
0°	8.00	1.66	8.50^{Aa}	1.54	7.30^{Aa}	1.87	8.20^{Aa}	1.36	0.068
2°	7.78	1.67	8.30^{Aa}	1.34	$7.00^{Ba.b}$	1.65	8.05^{Aa}	1.76	0.041*
4°	6.83	1.70	$7.00^{A.Bb}$	1.49	6.05^{Bb}	1.67	7.45^{Aa}	1.70	0.040*
6°	5.18	1.94	4.90^{Bc}	2.34	4.45^{Bc}	1.50	6.20^{Ab}	1.47	0.005*
8°	4.38	2.03	3.90^{Bd}	2.17	3.60^{Bc}	1.93	5.65^{Ab}	1.31	0.001*
p value[(2)]	< 0.001*		< 0.001*		< 0.001*		< 0.001*		

Values expressed in mean (M) and standard deviation (SD); *different letters indicate significantly different scores ($p < 0.05$)

[(1)] Capital letters compare values horizontally (evaluator intergroup analyses). [(2)] Lowercase letters compare values vertically (evaluator intragroup analyses)

Another variable observed in the present study was regarding the ethnicity of the models assessed. A study by Coetzee et al. [8] assessed facial attractiveness based on the ethnicity of the evaluator and the person evaluated, showing the importance of this variable when deciding on the most attractive profiles. In the present study, the images of the African model received higher scores than the images of the Caucasian model, with statistical difference between them. This result is similar to the one found by Barbosa et al. [19], who assessed the aesthetic perception of mandibular deviation in women of different ethnicities. One of the justifications presented by Coetzee et al. [8] was that evaluators, for residing in Europe, are more used to the facial characteristics of Caucasians, thus resulting in higher scores for this group. In the present study, due to the mixed-race population of Brazil, we believe that the best justification is that the African facial characteristics have minimized the different degrees of mandibular deviation, requiring a higher visual accuracy to be perceived, thus leading to higher attractiveness scores.

Considering the aesthetic subjectivity, the indications for corrective treatments also become subjective when they are not associated with functional problems. A previous study by McKeta, Rinchuse, and Close [20] showed a significant statistical difference between treatment indication from laypersons and professionals. In the present study, however, this difference was not found, as in the study by Barbosa et al. [19]. This contradiction may be justified by the different method of the studies, considering that the study by McKeta, Rinchuse, and Close [20] required that patients themselves indicated or not their own treatment, while the study by Barbosa et al. [19] and the present study required an opinion from a third party. Thus, we may assume that patients become more critical regarding their own appearance than that of third parties.

Just as the difference in aesthetic perception scores, there was also a significant difference between Africans and Caucasians regarding the indication of corrective treatment in certain degrees of deviation. Other studies [19, 21] have

Table 2 Comparative analysis of the rate of treatment indication checked by the evaluators according to ethnicity and degree of mandibular deviations of the images

Ethnicity/degree of deviations	Total sample ($n = 60$)		Group						p value[(1)]
			Orthodontists ($n = 20$)		Oral and maxillofacial surgeons ($n = 20$)		Laypersons ($n = 20$)		
	n	%	n	%	n	%	n	%	
Caucasian									
0°	15	25.0	6^{Ab}	30.0	5^{Ab}	25.0	4^{Ab}	20.0	0.930
2°	20	33.3	$10^{Aa.b}$	50.0	6^{Ab}	30.0	4^{Ab}	20.0	0.160
4°	42	70.0	13^{Aa}	65.0	13^{Aa}	65.0	16^{Ab}	80.0	0.537
6°	58	96.7	20^{Aa}	100.0	20^{Aa}	100.0	18^{Aa}	90.0	0.322
8°	57	95.0	19^{Aa}	95.0	20^{Aa}	100.0	18^{Aa}	90.0	0.766
p value[(2)]	< 0.001*		< 0.001*		< 0.001*		< 0.001*		
Asian									
0°	6	10.0	2^{Ac}	10.0	4^{Ab}	20.0	0^{Ac}	0.0	0.150
2°	12	20.0	3^{Ac}	15.0	4^{Ab}	20.0	5^{Ac}	25.0	0.919
4°	34	56.7	11^{Ab}	55.0	$11^{Aa.b}$	55.0	12^{Ab}	60.0	0.934
6°	46	76.7	18^{Aa}	90.0	16^{Aa}	80.0	12^{Ab}	60.0	0.099
8°	57	95.0	19^{Aa}	95.0	20^{Aa}	100.0	18^{Aa}	90.0	0.766
p value[(2)]	< 0.001*		< 0.001*		< 0.001*		< 0.001*		
African									
0°	4	6.7	1^{Ab}	5.0	2^{Ab}	10.0	1^{Ab}	5.0	0.999
2°	7	11.7	2^{Ab}	10.0	4^{Ab}	20.0	1^{Ab}	5.0	0.478
4°	20	33.3	6^{Ab}	30.0	7^{Ab}	35.0	7^{Ab}	35.0	0.928
6°	50	83.3	17^{Aa}	85.0	17^{Aa}	85.0	16^{Aa}	80.0	0.999
8°	54	90.0	19^{Aa}	95.0	19^{Aa}	95.0	16^{Aa}	80.0	0.344
p value[(2)]	< 0.001*		< 0.001*		< 0.001*		< 0.001*		

Values expressed in absolute frequencies and percentages; *different letters indicate significantly different ratios ($p < 0.05$)

[(1)] Capital letters compare values horizontally (evaluator intergroup analyses). [(2)] Lowercase letters compare values vertically (evaluator intragroup analyses)

also shown differences in treatment indications depending on the ethnicity of the person evaluated. As a justification of our results, we believe again that Africans have stronger facial traits that mask the mandibular deviation and consequently the treatment need.

The limitations of the present study highlight the subjectivity of aesthetic perception of each individual; also, the assessments were made with 2D images. On the other hand, the study has contributed to the scientific literature for being an original study, and the first on the aesthetic assessment of laterognathism and perception of treatment need using men of three different ethnicities and a confirmatory study that professionals are more training for detecting such asymmetries.

Conclusion

The results suggest that mandibular deviation is a major characteristic for aesthetic assessment, considering that the higher the degree of mandibular deviation, the lower the attractiveness. Moreover, oral and maxillofacial surgeons are more critical to assess mandibular deviation, followed by orthodontists and laypersons, although there was no difference in treatment indication by the different groups of evaluators. Besides, ethnicity may be an important characteristic in influencing perception and treatment indication.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study. Additional informed consent was

obtained from all individual participants for whom identifying information is included in this article.

References

1. Peck H, Peck S (1970) A concept of facial esthetics. Angle Orthod 40:284–318
2. Yin L, Jiang M, Chen W, Smales RJ, Wang Q, Tang L (2014) Differences in facial profile and dental aesthetic perceptions between young adults and orthodontists. Am J Orthod Dentofac Orthop 145:750–756
3. Xia Y, Leib AY, Whitney D (2016) Serial dependence in the perception of attractiveness. J Vis 16:28
4. Taubert J, Van der Burg E, Alais D (2016) Love at second sight: sequential dependence of facial attractiveness in an on-line dating paradigm. Sci Rep 6:1–5
5. Pithon MM, Nascimento CC, Barbosa GC, Coqueiro Rda S (2014) Do dental esthetics have any influence on finding a job? Am J Orthod Dentofac Orthop 146:423–429
6. Naini FB, Moss JP, Gill DS (2006) The enigma of facial beauty: aesthetics, proportions, deformity and controversy. Am J Orthod Dentofac Orthop 130:277–282
7. Theobald AH, Wong BK, Quick AN, Thomson WM (2006) The impact of the popular media on cosmetic dentistry. N Z Dent J 102: 58–63
8. Coetzee V, Greeff JM, Stephen ID, Perrett DI (2014) Cross-cultural agreement in facial attractiveness preferences: the role of ethnicity and gender. PLoS One 9:e99629
9. Duarte MEA, Machado RM, Motta AFJ, Mucha JN, Motta AT (2017) Morphological simulation of different incisal embrasures: perception of laypersons, orthodontic patients, general dentists and orthodontists. J Esthet Restor Dent 29:68–78
10. Monnet-Corti V, Antezack A, Pignoly M (2018) Perfecting smile esthetics: keep it pink! Orthod Fr 89:71–80
11. Springer IN, Wannicke B, Warnke PH, Zernial O, Wiltfang J, Russo PA et al (2007) Facial attractiveness: visual impact of symmetry increases significantly towards the midline. Ann Plast Surg 59: 156–162
12. Fonseca RJ (2017) Oral and maxillofacial surgery, 3rd edn. Saunders Company, Pennsylvania
13. Wilmot JJ, Barber HD, Chou DG, Vig KW (1993) Associations between severity of dentofacial deformity and motivation for orthodontic-orthognathic surgery treatment. Angle Orthod 63: 283–288
14. Epker BN (2004) Maxillofacial contour esthetic deformities. Atlas Oral Maxillofac Surg Clin North Am 12:75–89
15. Masuoka N, Muramatsu A, Ariji Y, Nawa H, Goto S, Ariji E (2007) Discriminative thresholds of cephalometric indexes in the subjective evaluation of facial asymmetry. Am J Orthod Dentofac Orthop 131:609–613
16. McAvinchey G, Maxim F, Nix B, Djordjevic J, Linklater R, Landini G (2014) The perception of facial asymmetry using 3-dimensional simulated images. Angle Orthod 84:957–965
17. Crerand CE, Sarwer DB, Kazak AE, Clarke A, Rumsey N (2017) Body image and quality of life in adolescents with craniofacial conditions. Cleft Palate Craniofac J 54:2–12
18. Jackson TH, Mitroff SR, Clark K, Proffit WR, Lee JY, Nguyen TT (2013) Face symmetry assessment abilities: clinical implications for diagnosing asymmetry. Am J Orthod Dentofac Orthop 144:663–671
19. Barbosa PBC, Santos PL, De Carli JP, Luiz de Freitas PH, Pithon MM, Paranhos LR (2017) Aesthetic facial perception and need for intervention in laterognathism in women of different ethnicities. J Craniomaxillofac Surg 45:1600–1606
20. McKeta N, Rinchuse DJ, Close JM (2012) Practitioner and patient perceptions of orthodontic treatment: is the patient always right? J Esthet Restor Dent 24:40–50
21. Chisini LA, Noronha TG, Ramos EC, Dos Santos-Junior RB, Sampaio KH, Faria-E-Silva AL, Corrêa MB (2018) Does the skin color of patients influence the treatment decision-making of dentists? A randomized questionnaire-based study. Clin Oral Investig 23:1023–1030. https://doi.org/10.1007/s00784-018-2526-7
22. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP (2007) Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ 335:806–808
23. Falkensammer F, Loesch A, Krall C, Weiland F, Freudenthaler J (2014) The impact of education on the perception of facial profile aesthetics and treatment need. Aesthet Plast Surg 38:620–631
24. Pithon MM, Santos AM, Coutto FS, Freitas LMA, Coqueiro RS (2012) Comparative evaluation of aesthetic perception of black spaces in patients with mandibular incisor extraction. Angle Orthod 82:806–811
25. Lu KH (1965) Harmonic analysis of the human face. Biometrics 21(2):491–505
26. Meyer-Marcotty P, Stellzig-Eisenhauer A, Bareis U, Hartmann J, Kochel J (2011) Three-dimensional perception of facial asymmetry. Eur J Orthod 33(6):647–653